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Internal consistency predicts attractiveness in biological motion walkers

Malte Klüver [a], Heiko Hecht [a], Nikolaus F. Troje [b,c,d,*]

[a] Psychologisches Institut, Universität Mainz, 55122 Mainz, Germany
[b] Department of Psychology, Queen's University, Kingston, ON K7L3N6, Canada
[c] Department of Biology, Queen's University, Kingston, ON K7L3N6, Canada
[d] School of Computing, Queen's University, Kingston, ON K7L3N6, Canada

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ABSTRACT

Why do some people appear attractive to us while others don't? Evolutionary psychology states that sexual attractiveness has evolved to assess the reproductive qualities of a potential mate. Past research in the field has identified a number of traits that can be linked directly to qualities such as immuno-competence, developmental stability, and fertility. The current study is motivated by the hypothesis that attractiveness is determined not just by individual, independent traits, but also by whether their pattern is internally consistent. Exploiting the domain of biological motion, we manipulated internal consistency between anthropometry and kinematics of a moving body. In two experiments, we varied internal consistency by using original point-light walkers (high internal consistency) and hybrid walkers, generated by combining anthropometric and kinematic data from different walkers (low internal consistency). As predicted, we found a significant link between internal consistency and sexual attractiveness, suggesting that internal consistency signals health and mate quality.

1. Introduction

"Beauty is everywhere a welcome guest" pondered Johann Wolfgang Goethe in his novel Elective Affinities. And indeed, physical attractiveness not only determines our mating behavior (Rhodes, Simmons, & Peters, 2005; Walster, Aronson, Abrahams, & Rottmann, 1966), but also influences our perception of others in many ways. Langlois, Kalakanis, Rubenstein, Larson, and Smoot (2000) showed in a meta-analytic review that attractive adults and children are judged and treated more positively and exhibit more positive behaviors and traits than unattractive individuals. Compared to others, attractive respondents have higher salaries (Judge, Hurst, & Simon, 2009; Roszell, Kennedy, & Grabb, 1989), physically attractive students are usually judged more favorably by teachers (Ritts, Patterson, & Tubbs, 1992), and the attractiveness of defendants affects juridical judgments (Sigall & Ostrove, 1975).

But what is attractiveness? Which traits contribute to the attractiveness of a person? Past research has focused on a number of candidate features that include averageness, symmetry, and sexual dimorphism. The latter can be conveyed by several secondary sexual characteristics. The width of jaw and cheek bone in males or a smaller chin, larger eyes, and fuller lips in females are just a few examples (see Rhodes, 2006, for a review on facial attractiveness). According to evolutionary psychology, our perception of sexual attractiveness has evolved to assess the reproductive qualities of a potential mate and there is good evidence to assume that many of the traits that convey attractiveness are linked to cues that honestly signal mate quality, such as general health, immuno-competence, developmental stability, genetic quality and fertility (Grammer, Fink, Møller, & Thornhill, 2003; Little, Jones, & DeBruine, 2011).

The investigations and discussions of local features such as more prominent jaws or larger eyes might imply that they contribute independently to the perception of attractiveness. That, however, is a rather unlikely assumption. Different properties of the human face, as well as the rest of the human body, are not independent of each other. The way the different parts of a normal, healthy body are formed is interrelated and highly redundant. Our perceptual system probably knows about these redundancies and is able to detect violations of the expected relations as they might be indicative for compromised health. Bilateral symmetry of the human body is just one example for redundancy in the building plan, and the fact that perceived attractiveness depends on symmetry is just one example for the observer's sensitivity to expected redundancy and gradual deviations from it.

Previous research showed that holistic processes play a crucial role in several areas of face perception, such as facial identity recognition (Young, Hellawell, & Hay, 1987), gender categorization (Baudoin & Humphreys, 2006), and facial-expression recognition (Calder, Young, Keane, & Dean, 2000). Additionally, it was found that emotion recognition from face–body composites is based on holistic processing (Aviezer, Trope, & Todorov, 2012). To our knowledge, only Abbas and Duchaine (2008) examined the role of holistic processing in judgments of facial attractiveness. Using a composite paradigm they observe holistic processing in the context of attractiveness judgments, too.

* Corresponding author: Department of Psychology, Queen's University, Kingston, Ontario, K7L 3N6, Canada. Tel.: +1 613 533 6017.
E-mail address: troje@queensu.ca (N.F. Troje).

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For the purpose of this study, we want to use the term "internal consistency" to refer to the coherency between different traits. Holistic processing and internal consistency are related but while the former term rather refers to the effects observed when working with hybrid stimuli, we aim to focus here on statistical dependency and redundancy within a multivariate stimulus class. As the shape of the left hand is a good predictor for the shape of the right hand, the morphology of one part of the body (say, the face) very likely predicts, at least to some degree, the morphology of other parts (say, the trunk and extremities). Combining an attractive face with an attractive body may result in an unattractive person if internal consistency is violated. Likewise does the appearance of the whole body, its anthropometry, determine the way it moves, its kinematics.

Deviation from the expected normal relations between anthropometry and kinematics of a moving body can be due to a number of reasons, many of which are potentially important to detect for an observer. For instance, for a predatory animal, uncoordinated behavior in another animal might signal young age, or it might be indicative for an animal that is injured or suffers pain—thus labeling the animal as easy prey. For intra-species communication, the assessment of deviations from coordinated motor behavior may provide an important cue towards health issues that could affect reproductive success. We would therefore expect that internal consistency affects attractiveness.

Research in the past decades has mostly focused on facial attractiveness and to a lesser extent on body attractiveness using static stimuli. For the current study, we will not work with facial attractiveness or static bodies, but with biological motion as introduced by Johansson (1973)—a stimulus domain that provides straightforward, principled ways to study the role of internal consistency on perceived attractiveness.

Only a few studies examined attractiveness as conveyed by body movements. Voracek and Fisher (2006) found that criteria for female sexual attractiveness differ, depending on whether women are depicted on pictures or whether they appear in videos, emphasizing the need for studies examining motion. Riggio, Widaman, Tucker, and Salinas (1991) showed that faces and dynamic components of the body are the most dominant cues to assess the overall attractiveness of a person. Sadr, Troje, and Nakayama (2006a) showed for female point-light walkers that symmetry increases the attractiveness of their gaits. Arend, Ward, Roether, Omlor, and Giese (2010) also found that symmetrical gaits are perceived as more attractive and more feminine than asymmetrical gaits. Giese, Arend, Roether, Kramer, and Ward (2009) examined the relationship between sexually dimorphic gait patterns and attractiveness by adapting different kinematics on female standardized volumetric puppets. Interestingly, they failed to find a relationship between perceived femininity and attractiveness. Instead, they found that a neutral gait pattern was preferred. This is surprising, given that sexual dimorphism in facial features has often been shown to play a crucial role (e.g. Grammer et al., 2003; Little et al., 2011; Rhodes, 2006). By varying sexual dimorphism of point-light walkers using morphing techniques, Sadr, Troje, and Nakayama (2006b) could show that not averageness, but sexual dimorphism enhanced the sexual attractiveness of a female gait.

In a study that explicitly addressed the consistency between body shape and body motion, Johnson and Tassinary (2007) found that sexually dimorphic gaits are preferred in both male and female walkers, but only when combined with a body shape that matched the sex of the movements. Male movement on a female body as well as female movements on a male body were perceived as less attractive. The authors hypothesized that their result is due to a perceived mismatch between "sex" (conveyed by body shape) and "gender" (conveyed by body motion).

However, the manipulations used by Johnson and Tassinary (2007) appear to be coarse compared to the fine details that human observers are able to detect in the movements and the anthropometry of other people. The effects of anthropometry and kinematics on the perception of an observer go way beyond the rather obvious differences between sexes. Both domains have been shown to carry information about a walker's identity (Troje, Westhoff, & Lavrov, 2005). Human observers seem to be particularly sensitive to the relations between spatial dimensions and temporal aspects of a movement—a relation that links individual differences in anthropometry directly to individual differences in body kinematics. Spatial and temporal parameters in both inanimate and biological dynamic systems are often related by means of gravity and the visual system seems to take advantage of these dependencies. Jokisch and Troje (2003) found that from the stride frequency of a walking point-light dog observers are able to estimate its size. We can also estimate the weight of a box which is lifted by a person in point-light displays (Bingham, 1987; Runeson & Frykholm, 1981; Shim, Hecht, Lee, Yook, & Kim, 2009). These findings indicate that the perceptual system can derive sophisticated information from biological motion that goes well beyond the one contained directly in their kinematics or their articulated body shape alone (Runeson & Frykholm, 1981). In doing so, the perceptual system likely draws on implicit knowledge about physical and biomechanical regularities of the world. It "knows" about the relations between kinematic and anthropometric parameters that determine body's movements. Inconsistencies within the appearance of a person may therefore play out on a much more subtle level than the one hypothesized by Johnson and Tassinary (2007) and may not require a conceptual distinction between "sex" and "gender" as proposed by these authors.

In the current study, we manipulate the level of internal consistency, expressed in terms of the match between anthropometric and kinematic cues, of individual biological motion walker and we measure how this manipulation affects perceived sexual attractiveness in human observers. Consistent walkers are walkers that retain both their own anthropometry and their own kinematics. Inconsistent walkers are hybrid walkers in which we combine anthropometry and kinematics from two different individual walkers (but always from the same sex). We predict that attractiveness of human point-light walkers is not just determined additively by the attractiveness of their kinematics and anthropometry, but particularly depends on whether the two components match.

2. Experiment 1

In our first approach to this question, we assumed that the overall attractiveness of a walker can be regarded as a function of the attractiveness of its anthropometric cues, its kinematic cues and the consistency between the two. In order to test the effect of internal consistency, we compared two linear models to predict the overall attractiveness of a walker. The first linear model (M1) includes only the attractiveness of anthropometric cues and kinematic cues as predictors of overall attractiveness of a walker and the second model (M2) also includes a measure of internal consistency. A comparison between the two models and the amount of variance explained by the consistency measure in M2 is used to assess and discuss our hypothesis.

We regarded the perceived attractiveness of original unedited walkers as the standard for overall attractiveness. In order to assess the perceived attractiveness of an individual walker from anthropometric cues alone, we created a hybrid walker by combining the anthropometric data of the walker with the kinematics of a standardized, sex-specific, average walker. Likewise to assess attractiveness based on kinematic cues alone, we paired individual movement patters with the sex-specific, average anthropometry. Male and female walkers were presented in separate blocks of original walkers, anthropometry-only walkers, and kinematics-only walkers respectively. The level of inconsistency was quantified in terms of the Euclidian distance in a parameterized walker space between the two walkers that contributed to the hybrid walkers. Since one of them was always the sex-specific average walker, the consistency measure was basically the distance of the particular walker from the corresponding average walker.

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